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Impact Of Technology-Engagement Teaching Strategy With The Aid Of Clickers On Student's Learning Style

Sibongile Simelane [a] *, Andile Mji [b]

[a] Tshwane University of Technology, P/Bag X680, Pretoria, 0001 South Africa
[b] Tshwane University of Technology, P/Bag X680, Pretoria, 0001 South Africa

Abstract

The challenges in this study were the lack of student participation and interaction, lack of understanding student learning styles' lack of immediate feedback on student learning throughout the lesson, insufficient time for regular formative assessment and low pass rate. The purpose of the study was to develop and integrate a technology-engagement teaching strategy (TETS) with the aid of clickers by classifying the learning styles of students in Mathematics I. To establish the changes in participants' academic performance, clicker continuous assessments conducted. The results showed that the useful implementation of TETS with the aid of clickers improved students' academic performance.

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Keywords: Clickers, technology teaching strategy, learning style, students academic performance

1. Introduction

The world over, the unprecedented advancement and development in technology are observed. In the latter years, technology has even emerged in the form of tablet computers, smart phones, smart phone apps, blogs, instant messaging and social networking sites. This development means that technology has had a positive influence in different contexts, including the education sector. The advancement has led to suggestions that students of the 21st century need to be taught according to 21st-century approaches (McCoog, 2008). In the education sector, new technologies such as web2.0 tools and related technology education programs are enabling teaching methods to follow the same trend (Simelane, Mji, & Mwambakana, 2011). Related technology education programs such as

* Corresponding author: Sibongile Simelane. Tel.: +27-12-382-5772
E-mail address: simelanes@tut.ac.za

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clickers have in fact taken centre stage, especially in higher education lectures. This is because the utility of clickers is such that one may use this technology to assess "… students' prior knowledge and identifying misconceptions before introducing a new subject" (Zhu, n.d.). Clickers represent instructional technology tools used by lecturers to gather and analyze students' responses to questions during class rapidly (Bruff, 2007; Simelane & Dimpe, 2011; Simelane et al., 2011). Clickers are reported to change passive lecture rooms into vibrant interactive learning spaces (Caldwell, 2005; Crouch & Mazur, 2001; Duncan, 2007; Mazur, 2009; Simelane & Skhosana, 2012). In fact, researchers (e.g., Duncan, 2007; Simelane and Skhosana, 2012) suggest that lecturers should use clickers regularly to promote active learning. More than anything, Beatty (2004) is of the view that the use of clickers could promote deep learning.

It should be mentioned, though, that technology itself does not actually improve learning. In this regard, Beatty (2004) argues that, while the use of clickers may be excellent for pedagogical purposes, technology however merely makes pedagogy more possible. Technology generally works when it is aligned with lecturers' educational philosophy and belief to " … encourage active learning, promote collaboration, increase student–faculty interaction and enrich the educational experience" (Mandernach & Taylor, 2011, p. 220). Furthermore, technology is also reinforced by other components of the entire course (Beatty, 2004). In integrating technology, what is important is that the focus should be on teaching and learning rather than on the technology (Henke, 2001).

This paper reports on the development and integration of technology-engagement teaching strategy (TETS) with first-year mathematics students. In doing this, we firstly determined participants' learning styles. The learning styles were solicited by participants responding to the Kolb Learning Style Inventory (KLSI). The KLSI is intended to identify participants' learning styles in order for the researcher to develop and align the TETS that addresses the learning needs of all participants. Secondly, a paper–based assessment was conducted initially to determine what students already knew. Much later, it was conducted again to evaluate the participants' understanding after they had been taught. Thirdly, the purpose of a questionnaire about what was happening in that class was used to determine the demographic of the participants, teaching and learning as well as assessments. Fourthly, the TETS was developed and integrated in teaching and learning. To establish the changes in participants' academic performance, weekly clicker continuous assessments were conducted.

2. Teaching and learning strategies

Literature identified a number of strategies that are used in the teaching and learning context. These strategies may be in the form of a top-down or teacher delivery strategy, a social or student–teacher strategy, or a bottom-up or student-centred strategy (Garrison & Anderson, 2003; Learning theories, n.d). Essentially, each strategy is selected by lecturers because they are comfortable with executing it (Garrison & Anderson, 2003). Teaching strategies are about the approaches lecturers, teachers or instructors follow to create conducive learning environments. Tied to this is the specification of the nature of the activity in which the lecturer and student will be engaged during the lesson (Lasry, Mazur, & Watkins, 2008). Largely, lecturers select teaching strategies on the basis of the information or skills they want to impart (Liu, Gibby, Quiros, & Demps, 2002). In fact, when selecting a strategy there are a number of key features a lecturer needs to look at. These features include focusing on: (a) the curriculum; (b) prior knowledge of students; (c) students' interests; (d) students' learning styles and (e) the developmental level of the students (Liu et al., 2002). What is also essential is to understand that a 'single-method'-fits all approach to teaching cannot meet the needs of all students (Felder & Brent, 2005). In fact, the more preferable situation is one that accommodates diverse needs of students. It may be concluded then that the activity of teaching is more than just information transfer (Mazur, 2009). What is critical is that lecturers should ensure that students understand concepts, and that they can reason and process information in order to apply it in real-life situations (Weller & Hopgood, n.d).

The development of technologies that can be used to make education more effective has created opportunities for the development of new methodologies in teaching and learning (Simelane, 2008). It is pointed out that the nature and needs of higher education are changing from classroom-based instruction to computer network-based learning (Katz, 1999, p.4). Twigg (2003) feels that higher education institutions would be much more effective if lecturers incorporated technology and the Internet in their teaching. An advantage of using technology is that online learning allows for people to see the big picture and think outside the box in order to make it possible to view practice (Anderson, 2004). Regarding online educational theory, Anderson (2004) points out that:

i) it assists us to envisage new worlds in the middle of the hype and enthusiasm of online learning that advocates the overflow of the popular press;
ii) a good theory assists us to make things; the theory of online learning assists us to limit resources and invest our time most effectively;
iii) good theory keeps us honest. It is constructed upon what is already known, and assists us to interpret and plan for the unknown. It forces us to look beyond possibilities and to ensure that our knowledge and practice of online learning are robust, considered and always expanding.

Guri-Rosenblit (2005) argues that the functioning of technology-enhanced learning is more likely to be part of a mixed method of teaching and learning than traditional teaching. In a South African study (Simelane, 2008), it was reported that lecturers of undergraduate students preferred a 'blended' or mixed style, especially for students who had never experienced technology-enhanced facilities before. A blended style relates to teaching or learning utilising a combination of different traditional teaching media, technologies, activities and type of events to create an optimum programme (Alvares, 2007).

Learning strategies, on the other hand, relate to the behaviour and thought that a learner engages in, which further influence the learner's encoding (Weinstein & Mayer, 1983). Researchers suggest that learning should be thought of as a change in the manner we conceptualise the world around us (Entwistle, McCune, & Tait, 2006; Tan & Low, 2010). Three learning and teaching theories, based on the constructivist theory, are identified, namely, experiential learning, social learning and situated learning (Learning theories, n.d). Constructivist theory advances that students are not a blank slate where new information is engraved, but that students make new meaning by incorporating it into pre-existing understanding (Zhu & Pandor, 2001). Weinstein and Mayer (1983) state that the aim of the learning strategy is to affect the manner in which a student selects, acquires, organises, and integrate new knowledge. The role of the learner in creating, monitoring and controlling a conducive learning environment is emphasised by the current classroom learning approaches (Simelane, et al., 2011). This means that how students adapt in the classroom is a function of the situation they encounter as it is presented by the teacher. Experiential learning is associated with Kolb's active learning cycle that is described in a four-stage model (Kolb, 2011; Learning theories, n.d.). About social learning, it is said, "… Albert Bandura (1977) states behavior is learned from the environment through the process of observational learning. Children observe the people around them behaving in various ways" (McLeod, 2011). Situated learning on the other hand, relates to learning as it usually occurs as a purpose of the activity, context and culture within which it occurs. Lave, (1991) argues that situated learning is a critical component of social interaction. Children become involved in a community of practice which expresses certain beliefs and behaviours to be acquired, and they become more active and engaged within the culture. It is pointed out by Lave, (1991) that situational learning is usually accidental rather than deliberate.

3. Teaching strategies using clickers

A number of teaching strategies using clickers have been identified. These strategies include the technology-enhanced formative assessment (TEFA), 'question cycle', 'concept test' and 'peer instruction model'. TEFA is a pedagogical approach developed for teaching science and mathematics using clickers (Beatty & Gerace, 2009). These authors state that TEFA is a modification and reinforcement of the assessing-to-learn pedagogy. Four principles inform technology-enhanced formative assessment. The principles are question-driven instruction, dialogical discourse, formative assessment, and meta-level communication (see Beatty & Gerace, 2009) for more information on dialogical discourse, formative assessment and meta-level communication. Question-cycle instruction is a model for organising classroom communication system-based teaching (see Beatty, 2004 for more information on this strategy). According to Beatty, the enhancement benefit of this model is that it allows students to be active participants in the learning process. Frequent feedback provided to students about the limitations of their knowledge encourages them to seek more information. Furthermore, this author argues that classroom communication system-based teaching can impact positively on students' approach to learning beyond the classroom (Beatty, 2004).

The question cycle (Beatty, 2004), concept test and peer instruction models (Mazur, 1997) came about because of a concern about teaching (Mazur, 1997). This author felt that he used the lecture method in imitation of how he was taught, and he concluded that such practice was not worthwhile (Mazur, 1997; Mazur, 2009). The concept test and peer instruction models incorporates the integration of clicker technology within the teaching and learning context (Lasry, et al., 2008). The model's modus operandi revolves around testing students' understanding of concepts through short, conceptual, multiple-choice questions. In the model a brief presentation by the lecturer is followed by a questioning technique that essentially encourages interactive exchanges between the lecturer and students (Mazur, 2009). Here students are given one to two minutes to think about and respond to questions using clickers (Mazur, 1997; Mazur, 2009). The onus for learning in this model remains with the students. This means that students need to read the study material before coming to class. Allowing students to read before coming to class is consistent with lecturers creating enabling environments where students may construct their own understandings (Zemelman, Daniels, & Hyde, 1993). In following this practice, the aim is to encourage students to be independent inquisitive thinkers, who investigate things for themselves (Fosnot, 1989). Furthermore, reading the study material beforehand, allows for class-based discussions, peer interactions and time to digest information (Mazur, 2009). Importantly, prior learning encourages students to work together, to learn new ideas, while having an opportunity to resolve misunderstandings (Crouch & Mazur, 2001; Mazur, 2009).

One benefit of using clickers as a teaching strategy is that it allows for peer collaboration in learning (Caldwell, 2005). Peer instruction is a student-centred approach to teaching that provides real-time feedback to multiple-choice questions or concept tests (Caldwell, 2005; Duncan, 2007; Mazur, 2009; Ricketts & Wilks, 2002; Simelane & Skhosana, 2012). The clickers could be used with several styles of questions where new variations on the technology allow other formats than multiple-choice questions (Barber & Njus, 2007). Another important aspect of clickers is that they elicit positive effects on student learning when used concurrently with active learning strategies, such as peer instruction (Crossgrove & Curran, 2008). It has been shown when clickers are used in conjunction with peer instruction, this leads to good results (Duncan, 2007). Peer instruction and other active learning approaches are said to lead to higher-order learning strategies that result in good examination scores when compared with traditional content-based approaches (Caldwell, 2005).

4. Learning style

Experiential learning theory propounded by William James, John Dewey, Kurt Lewis, Jean Piaget, Lev Vygotsky, Paulo Freire, Carl Jung, Carl Rogers, argues that learners construct knowledge by experiencing, reflecting, thinking and acting (Kolb & Kolb, 2005; Kolb, 2011). These 20th-century scholars gave experience a central role in their theories of human learning and development. Experiential learning theory defines learning as the process whereby knowledge is created through transformation of experience (Kolb, Boyatzis, & Mainemelis, 2000; Learning theories, n.d.). Experiential learning provides information about the learning process on how we know people learn, grow and develop (Kolb et al., 2000; Smith, 2001). Learning styles were derived from experiential learning theory (Kolb, 1984; Kolb et al., 2000).

Learning styles relate to characteristic cognitive, affective, and psychological behaviours that serve as indicators of how learners interact, respond and perceive the learning environment (Felder & Brent, 2005; Giles, Ryan, Belliveau, De Freitas, & Casey, 2006). It is argued that students have different learning styles and the manner in which they receive and process information is influenced by their characteristics, strengths and preferences (Felder, 1996). For example, in a mathematics context some students may be comfortable with theories and mathematical models, while others may focus on facts, data and algorithms (Felder & Brent, 2005). An important aspect here is that learning styles differ from student to student (Learning theories, n.d.). Hadden (2005) points out that lecturers should take this into cognisance when preparing learning content or activities. It is reported that making students aware of their learning styles assists them to learn better and become aware of their thinking processes (Felder, 1996). Furthermore, Felder (1996) indicates it helps students to discover their interpersonal skills, which are critical to their success in any professional career. This has been such an issue that researchers (e.g. Giles, et al., 2006) have explored, whether teaching styles should be matched with learning styles. As an answer to this, Felder and Brent (2005) have shown that teaching styles when matched with learning styles result in favourable learning outcomes.

Two dialectically related modes of grasping experience, namely concrete experience (CE) and abstract conceptualisation (AC), and two dialectically related modes of transforming experience, namely reflective observation (RO) and active experimentation (AE) are described in literature (Felder, 1996; Kolb et al., 2000;

Learning theories, n.d.; Nolting, 2009; Warren, 2004; Webster, 2002). Concrete experience and reflective observation are described as diverging dominant styles. People following diverging dominant styles are best at viewing concrete situations from different perspectives (Kolb, 1984; Kolb et al., 2000; Smith, 2001). Such people reportedly perform better in situations that call for general ideas, such as during a brainstorming session (Kolb, 1984; Kolb et al., 2000). In this regard, Kolb et al., (2000) indicate that people with diverging learning styles are interested in people, are emotional and imaginative, have wide cultural interest and mostly specialise in art. On the other hand, abstract conceptualisation and reflective observation are described as assimilating dominant learning styles (Kolb, 1984; Kolb et al., 2000; Smith, 2001). People in this category are best at understanding a broad spectrum of information in a logical form (Kolb, 1984; Kolb et al., 2000; Smith, 2001). People following assimilating dominant learning styles are less focused on individuals and more interested in abstract concepts and ideas. People categorised into this learning style are reported to prefer lectures, to explore analytical models, to prefer reading and having time to think things through while they favour careers in science (Kolb, 1984; Kolb et al., 2000; Smith, 2001).

Abstract conceptualisation and active experimentation meanwhile are described as converging dominant learning styles (Kolb et al., 2000; Smith, 2001). Individuals following the converging dominant learning style are reported to prefer technical tasks and will avoid interpersonal and social issues (Kolb et al., 2000; Smith, 2001). Concrete experience and active experimentation are the accommodating dominant learning styles (Kolb, 1984; Kolb et al., 2000; Smith, 2001). The ability to learn from primary hands-on experience is revealed by people in this learning style. They enjoy involving themselves in new and challenging experiences. Kolb et al. (2000) argue that people in this category tend to act on gut feeling rather than after logical analysis. It is reported that individuals following the accommodating dominant style rely on others for information rather than on their own technical analysis (Kolb et al., 2000; Smith, 2001).

5. Method

5.1. Participants

Participants were 105 first-year mathematics students at a university of technology in South Africa. In South Africa, a university of technology is what is typically referred to as a polytechnic in other parts of the world. The first-year mathematics syllabus covers functions, exponents, wave theory, complex numbers, differentiation, integration and matrices.

6. Instruments and procedure

6.1. Kolb learning style inventory

To collect data on students' learning styles Kolb's Learning Style Inventory (KLSI) 3.1 (Kolb et al., 2000) was used. The KLSI 3.1 is a 12-item inventory comprising of four primary subscales that measure concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active experimentation (AE). Scores from the subscales are combined to measure an individual's preference for abstractness over concreteness (AC–CE) and action over reflection (AE–RO) (Kolb & Kolb, 2005). The accommodating, diverging, converging and assimilating learning style types are created by dividing the AC–CE and AE–RO scores and plotting them on the learning style grid (Kolb & Kolb, 2005). A typical example of an item from this subscale is "When I learn, I like doing things and when I learn, I like to watch and listen".

The second subscale is the diverging learning style. This refers to students who are more dominant in concrete experience (CE) and reflective observation (RO). A typical example from this subscale is "When I learn, I am open to experiences and I learn best when I rely on my observations".

The third subscale is the converging learning style. A typical example from this subscale is "When I learn, I like ideas and theories and when I am learning I am an active person".

The fourth subscale is the assimilating learning style. A typical example from this subscale is "I learn best from rational theory and I learn best when I listen and watch carefully."

In terms of the reliability of scores obtained from the KLSI 3.1, Cronbach's alpha as a measure of the internal consistency of scores is reported to be .70 (Kolb & Kolb 2005). These authors indicate that they computed good internal consistency across a number of populations using the KLSI 3.1 (Kolb & Kolb 2005). With respect to the four subscales they reported $\alpha = .81$ (CE); $\alpha = .78$ (RO); $\alpha = .83$ (AC) and $\alpha = .84$ (AE) for scores from liberal arts college students. Similar alpha values were obtained with psychology undergraduate students. Further, values such as $\alpha = 0.80$ (CE); $\alpha = 0.77$ (RO); $\alpha = 0.70$ (AC); and $\alpha = 0.58$ (AE) were reported (Kolb & Kolb 2005).

6.2. Paper-based tests

There were two paper-based tests. The first test was meant to determine what students already knew. We referred to this test as the 'orientation test' and it was conducted before any teaching. The orientation test had ten questions covering exponents, functions, trigonometry and hyperbolic functions. The second test was conducted after the students had been taught. This test was not the same as the orientation test; however, the same topics were covered and four questions were set. Here we wanted to determine whether there was any change after the teaching intervention. For instance, students were asked to solve for (i) $\frac{x+2}{2} = 3$ and (ii) plot $y = 2$ tanh.

6.3. What is happening in this class

A questionnaire, 'What is happening in this class (WiHC)' developed by ourselves was administered. The questionnaire was divided into three sections. In the first section, students were requested to provide demographic data such as gender and age. The second section covered issues related to teaching and learning where students registered their views on a 3–point Likert-type rating scale anchored by 1 = all the time, 2 = about half the time and 3 = never. In this instance, the aim was to determine how things were done in class. For example students had to rate the items (i) Does the lecturer come prepared to class? (ii) Are you allowed to ask questions in class? The third section was about issues relating to assessment. This section had three parts. The first part requested students to indicate whether, for instance, pre-tests, remedial and post-tests were used in their classroom. In the second part, students had to indicate in which form the tests were. For example, was the assessment paper-based or electronic? In the case of electronic assessment, students were given choices to select from. The third part was about issues relating to assessment feedback.

7. Results

7.1. Participants

In all, there were 105 participants. Of those who provided all the information required in this investigation, 14 (13.3%) were women and 29 (27.6%) men. Of the rest of the participants, five (10.4%) did not indicate their sex and 57 (54.3%) did not respond to the questionnaire. While the 57 students wrote the assessment test, they were not included in the analysis of the study. Effectively, of the 105 students 48 were included in this study. Participants' ages ranged between 17 and 31 years ($M = 1.67$, $SD = .474$). Forty-one participants (85.5%) were in their first year of registration for the course whiles five (10.4%) were repeating the course for the first time, 1 (2.1%) participant was repeating the course for the second time and 1 (2.1%) participant was repeating the course for the fourth time.

7.2. Learning style

Table 1 shows the means, Cronbach's alpha (Cronbach, 1951) values obtained from scores of the KLSI by the mathematics students as well as the confidence intervals. It may be observed from Table 1 that the alpha values ranged between 0.82 and 0.86. The alpha values were fair (greater than or equal to 0.70 and less than 0.90) (Cicchetti, 1994). Reliability was acceptable here because the internal consistency of scores from the students was comparable to that reported by Kolb and Kolb, (2005). The validity of the instrument meanwhile was accepted a priori as the development of the instrument is adequately described by Kolb and Kolb, (2005).

Table 1: Descriptive statistics for the reported KLSI factor

		M	*SD*	α	95% CI
Concrete experimental	(12 questions)	32.47	7.413	0.82	.73 - .89
Reflective observation	(12 questions)	36.64	7.911	0.86	.79 - .91
Abstract conceptualisation	(12 questions)	36.04	6.947	0.86	.79 - .91
Active experimentation	(12 questions)	39.77	6.407	0.82	.73 - .89

To determine the cycle of learning that each participant preferred, participants' scores were added up as described in the KLSI 3.1 analysis guide (Kolb & Kolb, 2005). This was done by determining the total scores for AC–CE and AE–RO in order to categorise participants according to the preferred learning style. Out of 48 students, 47 students responded to the KLSI and 1 did not complete the questionnaire. Figure 1 shows the categorisation of students according to the four learning styles. It is noticeable from Figure 1 that the majority 18 or 38%) were categorised as diverging.

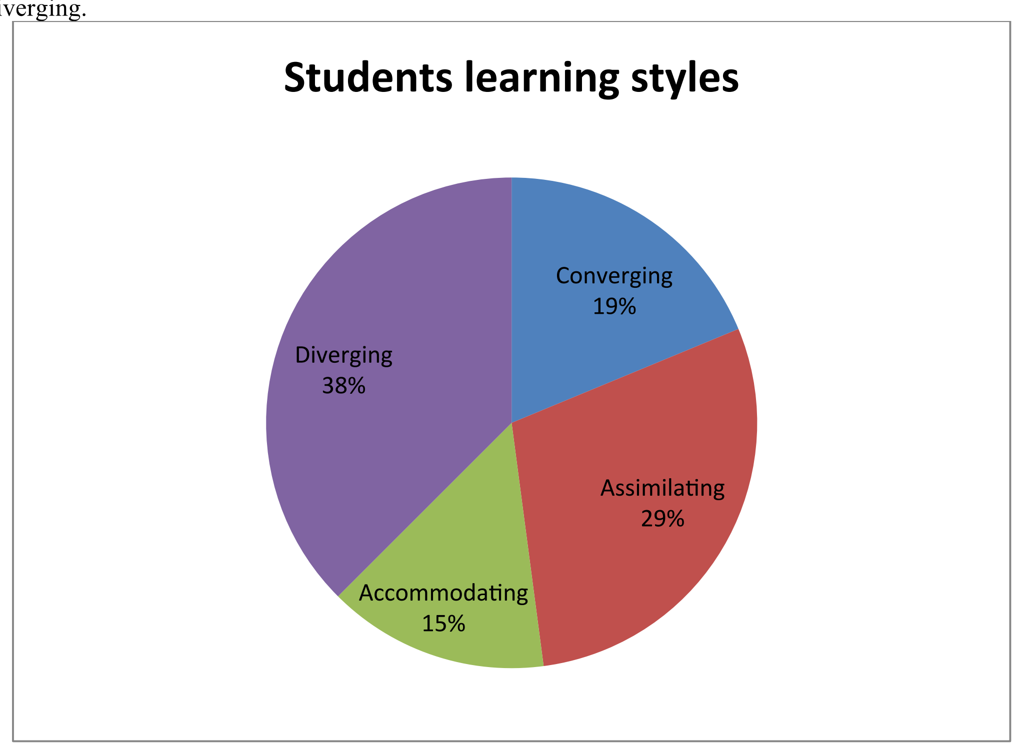

Figure 1: Percentage distribution of students according to learning styles (n = 43)

Table 2 shows the frequency distribution of the students' learning styles with respect to the gender and whether students passed or failed the two paper-based tests. The table reveals that most males (11 or 37.9%) were assimilators while females (8 or 57.1%) were divergers. There were 36 (75%) students who took the orientation test and most (11 or 30.6%) of those who were divergers passed. With respect to test 1 on the other hand, all the students wrote this test. Results for the all students show that 22 (45.8%) passed test 1. It is also noticeable that those who passed, were evenly categorised as divergers, assimilators and accommodators. However, among those who failed test 1, most (11 or 42.3%) were divergers.

Table 2: Frequency distribution (%) of learning styles with respect to gender as well as well as the two paper-based tests

Learning style	Gender		No sex	Orientation test		Test 1	
	Male	Female		Pass	Fail	Pass	Fail
Diverging	9	8	1	11	3	7	11
Assimilating	11	1	4	9	2	6	8
Converging	7	2		4	1	3	4
Accommodating	2	3		4	-	6	3

7.3. Clicker tests

Table 3 shows the frequency distribution (%) of clicker continuous tests (CCT) 1, 2 and 3 by learning style. It is noticeable that all the students passed clicker test 1, and these were divergers or assimilators. In clicker test 2, 28 (68.2%) students passed. Regarding clicker test 3, most (88.6%) of the students passed. Also, as in the two previous tests the students were divergers or assimilators.

Table 3: The frequency distribution (%) of clicker test 1, 2 and 3 by learning style

Learning style	CCT1 (n = 43)		CCT2 (n = 41)		CCT3 (n = 44)	
	Pass	Fail	Pass	Fail	Pass	Fail
Diverging	15	-	9	6	13	2
Assimilating	13	-	10	3	12	1
Converging	8	-	5	3	8	1
Accommodating	7	-	4	1	6	1

7.4. Views about 'What is happening in this class'

Here the findings indicated that most students attended lectures and participated while their lecturers were prepared. On the other hand the students felt that the lecturer did not ask questions in class for half the time they spent in lectures. In addition, students indicated that they received individual feedback at the same time. It should be mentioned that in both occasions of asking questions and receiving feedback in class about a quarter of the students indicated that these two never took place. The results showed that 48 (100%) students responded to the questionnaire.

Table 4: The participants' rating on teaching and learning

Item	All the time	About half of the time	Never
1. How often do you attend lectures?	47 (97.9%)	1 (2.1%)	-
2. Lecturer comes to class prepared	47 (97.9%)	1 (2.1%)	-
3. Participation in the classroom	31 (64.6%)	13 (27.1%)	4 (8.3%)
4. Ask questions in class	10 (20.8%)	28 (58.3%)	10 (20.8%)
5. When do you receive individual feedback in class?	12 (25.0%)	24 (50.0%)	12 (25.0%)

Results from the section of the questionnaire that requested students to select more than one answer where applicable, also showed that various teaching media were used during class presentation. Traditional media were mostly used because students indicated the use of the white board (44 or 91.7%), textbook (33 or 68.8%), study guide 26 (54.2%) and overhead projector 7 (14.6%) in class. Students (24 or 50%) also identified the use of technology in the form of learning management software (e.g. Blackboard). When asked "What do you do if you do not understand concepts taught in class?" the responses were 31 (64.6%) students, indicated that they asked other students, 26 (52.1%) consult other sources, 19 (39.6%) struggled until they find the solution, and 12 (25%) consulted the lecturer. Further, they were asked, "When do you receive answers to questions asked in class?" Here, 41 (85.4%) students indicated that they received answers immediately during class, 9 (18.8%) students indicated that the lecturer sometimes attempts to respond to their questions in class, 13 (27.1%) revealed that answers are provided by other students and 6 (12.5%) reported that the do not receive answers because they do not ask questions.

8. Conclusion

It was important in this study firstly to determine students' learning styles so that we could develop a Technology Engagement Teaching Strategy (TETS) that would give learning opportunities to all the students and accommodate different learning styles. Secondly, the strategy was to create the most effective learning environment for the students and the lecturer. Thirdly, the lecturer needed to adjust the teaching style and teaching medium by using a variety of teaching opportunities that accommodated different learning styles. Felder and Brent (2005) argue that, for lecturers to design a balanced teaching approach that addresses the learning needs of all their students, it is important to consider the application of learning styles. Looking closely at the results, participants were then grouped according to their dominant learning styles as well their academic performance. In this study, it was reported that most students' learning styles were either diverging or assimilating.

Divergers prefer- to work in groups. In consideration of the students following this learning style, group work activities were taken into consideration during the development of the TETS. Furthermore, assimilators like to focus on concepts and ideas, and these have to be tested to make sure that they have grasped and understood the concepts. An important feature of our intervention was the prompt feedback provided by the clicker system immediately after continuous assessment. The feedback was discussed in class in order to resolve issues and come up with solutions. This was accomplished with the help of the lecturer or by students on their own. This strategy does not leave anyone behind. Engagement and active participation of the students are crucial. The approach behind the TETS thus allows and promotes interaction and active learning.

9. Limitations

The limitations of this study were that it focused only on one mathematics class group with 105 students. While we would have preferred to work with 105 students, 57 students did not answer the questionnaire because the study was voluntarily and they were also given the permission not to participate if they did not feel like. Students did not own clickers; clickers were loaned for the period of six months from the Department of Teaching and Learning with Technology. The other limitation was that the lecturer relied fully on the first author, especially with the management and logistics of the clicker technology. This was due to the time allocated for the each period, it was too short.

10. Recommendations

Based on the findings reported here, it is recommended that lecturers, teachers and instructors should take into consideration students' learning styles. This will be possible if lecturers design teaching- strategies, methods and approaches in such a way that these accommodate students' preferred learning styles. Accommodating students' preferred learning styles should be invaluable in helping students improve academically. Perhaps, an important practice could be for lecturers, teachers and instructors to administer a learning style inventory from time to time. When this is common practice and part of their teaching, it will be easier to prepare appropriate teaching materials to assist specific students. The practice of regular assessment of students' learning styles may further be enhanced by lecturers themselves determining lecturers teaching styles and approaches to teaching. The results reported in this paper are promising; however, we feel that there is need for follow-up studies. It is our recommendation therefore that further studies should explore the issues investigated here perhaps with other groups of mathematics students. In addition, similar research including the TETS should be conducted with a larger number of mathematics students.

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